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ANATOMIC VARIATIONS

Type 2 proatlantal intersegmental artery associated with persistent trigeminal artery diagnosed by MR angiography

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Abstract
Purpose The type 2 proatlantal intersegmental artery (PIA) is a rare anastomosis between the external carotid artery (ECA) and vertebral artery (VA) that passes through the foramen magnum. The persistent trigeminal artery (TA) is the most common anastomosis between the internal carotid artery (ICA) and basilar artery. The purpose of this paper is to present the first case of a type 2 PIA associated with an ipsilateral persistent TA diagnosed using magnetic resonance (MR) angiography, and we briefly discuss the embryology of this rare anomaly.
Methods An 83-year-old man with cerebral infarctions underwent cerebral MR imaging, and head and neck MR angiography using a 1.5 T imager. MR angiography was obtained using the standard non-contrast three-dimensional time-of-flight technique.
Results MR angiography showed aplasia of the proximal left VA and a large anastomotic artery between the left ECA and distal left VA that passed through the foramen magnum, indicative of a type 2 PIA. This patient also had an anastomosis between the precavernous segment of the left ICA and midbasilar artery via a lateral course, indicative of a lateral-type persistent TA.
Conclusion We present the first case of type 2 PIA associated with ipsilateral lateral-type persistent TA diagnosed by MR angiography. MR angiography should be performed including the carotid bifurcation to find more frequently extracranial arterial variations, including type 2 PIAs.

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Keywords Type 2 proatlantal intersegmental artery · Persistent trigeminal artery · Occipital artery · External carotid artery · Magnetic resonance angiography

Introduction

Four types of persistent fetal anastomosis between the carotid and vertebrobasilar arteries have been described. From caudal to cranial, these are the proatlantal intersegmental artery (PIA), hypoglossal artery, otic artery, and trigeminal artery (TA) [11]. The otic artery may not persist after birth [2]. The PIA is extremely rare and comprises 2 types; type 1 arises from the internal carotid artery (ICA) and type 2, from the external carotid artery (ECA) [6]. Type 2 PIA is a rare congenital anastomosis between the proximal ECA and vertebral artery (VA) and passes through the foramen magnum. The exact incidence of this anomaly is not known. The persistent TA is the most common type of anastomosis having a reported incidence of about 0.2% [8].

Case report

An 83-year-old man with cerebral infarctions underwent cerebral magnetic resonance (MR) imaging, and head and neck MR angiography using non-contrast three-dimensional time-of-flight technique. MR angiography showed aplasia of the proximal left VA and a large anastomotic artery between the left ECA and distal left VA that passed through the foramen magnum (Figs. 1, 2, 3), from which the distal branch of the occipital artery (OA) arose (Fig. 2). Thus, the proximal segment of the anastomotic artery was regarded as a markedly dilated OA, and we diagnosed this

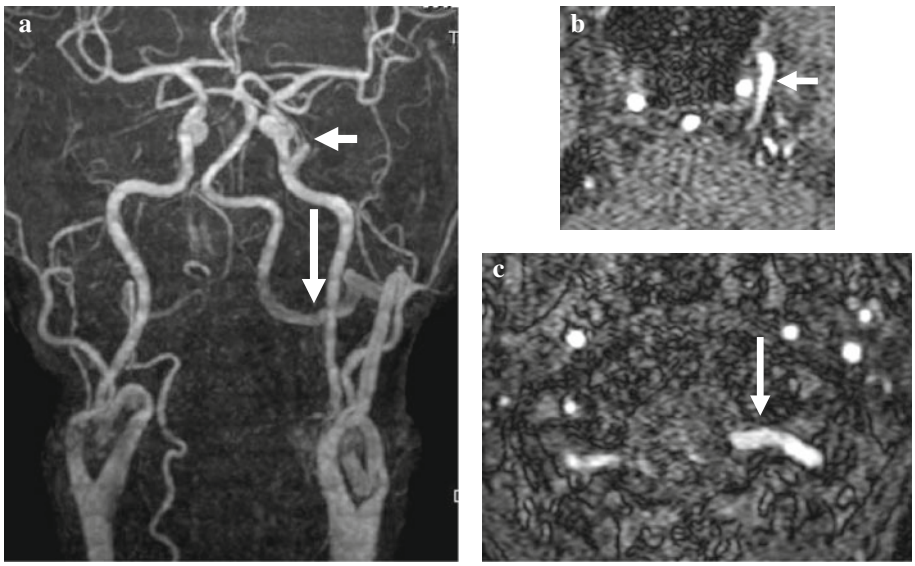

Fig. 1 Anteroposterior projection of MR angiography (**a**) showing a large anastomotic artery between the left ECA and the left VA passing through the foramen magnum, indicative of a left type 2 PIA (*long arrow*). There is also an anastomotic artery between the C3 segment of the ICA and the midbasilar arteries that takes a lateral course, indicative of a left lateral-type persistent TA (*short arrow*). The proximal segment of the left VA is absent. The right VA is hypoplastic and only supplies the right PICA. The bilateral posterior communicating arteries are absent. The cervical segments of the bilateral ICAs are extremely tortuous, probably resulting from atherosclerosis. Note the hypoplasia of the left A1 segment of the ACA. MR angiographic source images (**b**, **c**) demonstrating that the left persistent TA is a lateral type, and that the large anastomotic vessel passing through the foramen magnum

as a type 2 PIA. The right VA was hypoplastic and only gave arise the right posterior inferior cerebellar artery (PICA). This patient also had an anastomosis between the C3 segment of the left ICA and midbasilar artery via a lateral course, indicative of a lateral-type persistent TA. The bilateral posterior communicating arteries were absent, so only these two persistent anastomotic arteries supplied the vertebrobasilar system, excluding the right PICA.

Discussion

Lasjaunias et al. [6] initially classified the PIA into two types, type 1, arising from the ICA, and type 2, from the ECA. The type 1 PIA is regarded as a persistent Padget's PIA, and the type 2 may be a persistent first cervical intersegmental artery [15]. Kolbinger's group [5] described the PIA arising from the ECA (57%), ICA (38%), or carotid bifurcation (5%), and the type 2 PIA preferably located on the left side (68%). Thus, our patient had the most frequent type of PIA.

The PIA maintains the posterior circulation, until the VAs are fully developed between the seventh and eighth gestational weeks [15]. If the ipsilateral or both VAs are hypoplastic, the PIA persists, just as in our patient. Okumura and associates [9] reported a pediatric case of bilateral type 2 PIAs with bilateral VA absence. Thus, the PIA plays an important role in collateral circulation from the carotid to the vertebrobasilar system. Because the distal branch of the

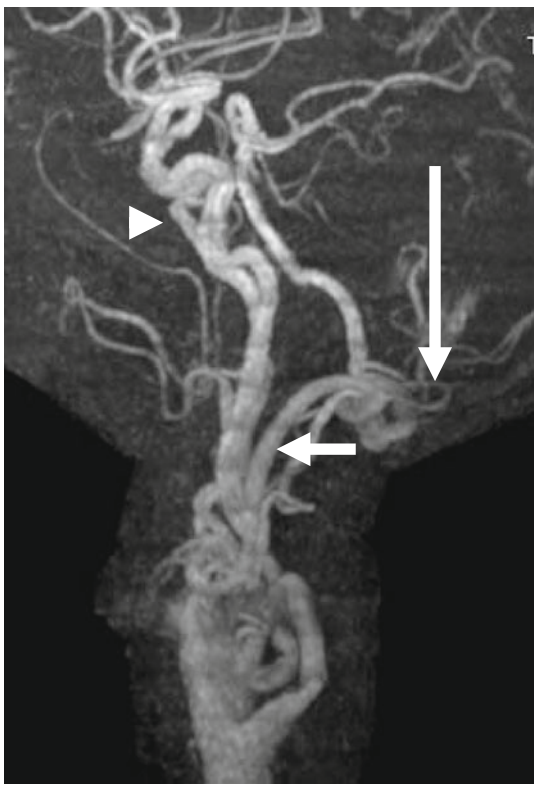

Fig. 2 Lateral projection showing a left type 2 PIA (*short arrow*) and left persistent TA (*arrowhead*). The distal segment of the left OA arises from the anastomotic artery (*long arrow*)

Fig. 3 Right anterior oblique projection from which the right carotid system was deleted, clearly demonstrating a left type 2 PIA (*arrow*) and left persistent TA (*arrowhead*). The proximal segment of the left VA and the V4 intracranial segment of the right VA are absent

OA can arise from the type 2 PIA, as in our patient, the type 2 PIA is considered to be a markedly dilated collateral vessel to the VA via the OA. Normally, there are small direct or indirect anastomoses between the OA and the VA. If a pressure gradient presents between the OA and the VA, these anastomoses subsequently dilate. These postnatal collaterals should not be confused with the PIA [12].

The PIA can be associated with other anomalies of the supraaortic arteries. Horowitz's team [4] reported a case of type 2 PIA associated with the ipsilateral ECA originating from the aortic arch. Tanaka's group [14] reported a case of type 1 PIA associated with a contralateral persistent TA. Recently, O'uchi et al. [10] reported 48 cases of persistent TA diagnosed by MR angiography. In their large series and the literature review, no case associated with other carotid-vertebrobasilar anastomosis was found. Our patient had a left type 2 PIA and an ipsilateral persistent TA. To our knowledge, this is the first reported case of such association. The persistent TA also serves as congenital collateral circulation from the ICA to the basilar artery. Thus, in our case, we speculate that the TA persisted because of insufficient collateral blood flow via the PIA.

Using computed tomography (CT) angiography, Akay et al. [1] reported a case of incidental type 2 PIA and noted that as CT angiography is used more frequently in routine clinical practices; radiologists will discover persistent vessels more frequently. We agree and believe that PIAs may be found more frequently if cerebral MR angiography is routinely performed including the carotid bifurcation.

Most PIAs were found incidentally without clinical symptoms or signs, but type 2 PIA may cause pulsatile tinnitus [7]. Although the type 2 PIA itself is of no clinical significance in some cases, its recognition is important if surgical ligation or embolization of the ECA is planned. Persistent TAs are usually asymptomatic but rarely cause cranial nerve symptoms, such as trigeminal neuralgia [13] and oculomotor nerve palsy [3].

Conclusions

We report the first case of a type 2 PIA associated with an ipsilateral persistent TA diagnosed by MR angiography. MR angiography should be performed including the carotid bifurcation to find more frequent extracranial arterial variations, including type 2 PIAs.

Conflict of interest None.

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